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THE COSTS AND EFFECTIVENESS OF THREE VITAMIN A INTERVENTIONS IN GUATEMALA

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ACRONYMS

A.I.D.	-	U.S. Agency for International Development
ASAZGUA	-	Guatemalan Sugar Association
CE	-	Cost-effectiveness
CI	-	Consumption index
COGUANOR	-	Guatemalan Commission for Norms
CR	-	Regional Advisory Commission for Vitamin A
DGLV	-	Dark green leafy vegetables
DGSS	-	Directorate General of Health Services, MOH
DIGESA	-	Directorate General of Agricultural Services, Ministry of Agriculture
DRCA	-	Directorate for Registry and Food Control, MOH
FAO	-	Food and Agriculture Organization
GOG	-	Government of Guatemala
HKI	-	Helen Keller International
HOPE	-	People-to-People Health Foundation, Inc.
IEF	-	International Eye Foundation
INCAP	-	Institute of Nutrition for Central America and Panama
IU	-	International Units
IVACG	-	International Vitamin A Consultative Group
KAP	-	Knowledge, Attitudes and Practices
LAC	-	Latin America and the Caribbean
LAC HNS	-	Latin America and Caribbean Health and Nutrition Sustainability
LUCAM	-	Unified Laboratory for Control of Foods and Medicines, MOH
MOA	-	Ministry of Agriculture
MOE	-	Ministry of Education
MOH	-	Ministry of Public Health and Social Assistance
PAHO	-	Pan American Health Organization
PCM	-	Protein Calorie Malnutrition
PVO	-	Private Voluntary Organization
RDI	-	Recommended Daily Intake
UNICEF	-	United Nations Children's Fund
WHO	-	World Health Organization
μg	-	Microgram

EXECUTIVE SUMMARY

This report presents the results of an analysis of the cost-effectiveness (CE) of three approaches to providing vitamin A in Guatemala, with the following objectives: (1) to demonstrate how assessment of the relative efficiency of alternative vitamin A interventions (i.e., their cost-effectiveness) can be undertaken relatively rapidly using secondary sources of data; and (2) to develop a framework to assist those in Guatemala interested in applying this method to other vitamin A interventions which have not been explored in this study.

Guatemala has one of the highest prevalences of vitamin A deficiency in the Latin America and Caribbean region. Three vitamin A programs to address this problem which have been underway for several years are the object of analysis in the present report: (1) fortification of sugar for domestic consumption, a public-private collaborative effort of the Government of Guatemala and the Guatemalan sugar industry; (2) oral supplements--capsules--distributed in collaboration with the government health care system to young children and women of reproductive age in a geographically delimited, high prevalence area; and (3) promotion of home garden vegetable production and consumption through an agricultural extension program targeted to a region with widespread chronic vitamin A dietary deficit.

To permit valid comparisons between these alternatives, the same set of effectiveness indicators and the same cost indicator (annual costs including recurrent costs and annuitized capital costs) were employed for each of the programs. Data used to generate the cost and effectiveness estimates for each program were collected from implementing agencies in Guatemala. When precise data were not available, sensitivity analyses were conducted using a range of plausible assumptions. Potential increases in cost-effectiveness due to improvements in program performance operations were also explored.

The analysis found cost per high risk person achieving adequate vitamin A to be US$ 0.98 for fortification, US$ 1.86 for capsule distribution, and US$ 2.71 to US$ 4.16 for gardens. Our main conclusion is that fortification can be an economically attractive option for meeting the vitamin A needs of much of the Guatemalan population if vitamin A levels in sugar are maintained at reasonable levels. The present program appears to be wasting fortificant--the most expensive component of costs. The magnitude of this inefficiency suggests that it would be economically rational to increase the very small quantities currently invested in monitoring the loss of vitamin A potency in fortified sugar in order to assure that minimally adequate levels of fortification are maintained. It is recommended that a stability study be undertaken of the fortificant from importation to consumption to determine the pattern of loss. Such a study would assist in the design of a more efficient monitoring system.

For those areas where fortified sugar is not consumed and vitamin A deficiency is highly prevalent, small-scale, carefully targeted, complementary interventions may be called for: capsules and, perhaps, gardens for sustained as well as broader impacts. Both these programs might be cost-effectively expanded in the areas they are currently serving by increasing participation rates within the target communities.

1.0 INTRODUCTION AND METHODS

1.1 Purpose of the Study

Guatemala has one of the highest prevalences of vitamin A deficiency in the Latin America and Caribbean region. According to criteria established by the World Health Organization, vitamin A deficiency among Guatemalan children under the age of five is a serious public health problem. The most recent national study, conducted in 1988, found low serum levels of vitamin A in an estimated 22 percent of all young children (Piñeda, 1990).

There is considerable evidence that rectifying vitamin A deficiencies not only creates important health benefits but can do so with a relatively low investment of resources (Sanghvi, 1993). The 1993 World Development Report presents results demonstrating the high cost-effectiveness of vitamin A vis-a-vis other health interventions. These results suggest that vitamin A programs are an appropriate priority for Guatemala. And indeed, a significant proportion of the Guatemalan population is currently being reached through a package of such programs. A national sugar fortification program was started in 1987-88 and was subsequently complemented by geographically targeted interventions of capsule distribution and garden promotion schemes in areas where localized deficiencies were detected.

The present study set out to address the following question: given that prevention of vitamin A deficiency is a priority in Guatemala, how is this best achieved? We explore this question in the Guatemalan context where doubts have been expressed as to whether fortification is an efficient approach due to the untargeted nature of the intervention. To assist in answering this question, the relative cost-effectiveness of the three interventions has been calculated to reveal which intervention produces the biggest reduction in vitamin A deficiency per dollar (quetzal) spent.

The basic rationale for cost-effectiveness analysis is that both impact and resource use are relevant when attempting to make choices between alternative investments; it is a rationale which policy-makers are seeing as increasingly relevant in the current times of stringent financial constraints. The technique can be employed to determine priorities between broadly defined health interventions (as illustrated by the 1993 World Development Report) or, as is done in this study, to explore issues of priorities at the next level of decision-making, to aid in selecting specific delivery strategies **within** these broadly-defined health interventions.

The cost and effectiveness results for each of the three interventions (fortification, capsules, gardens) were calculated using available secondary data and educated estimates, demonstrating that such assessments can be undertaken relatively rapidly and do not necessarily require major primary data collection efforts. The methodology and results are presented using a framework designed to be of use to others wishing to apply this approach elsewhere or to vitamin A programs which have not been explicitly explored in this paper, including modifications of the three programs studied.

This study forms part of a set of cost-effectiveness studies being undertaken by the USAID-funded Latin America and Caribbean Health and Nutrition Sustainability (LAC HNS) contract whose objective is to improve the capacity of nutrition program planners and implementers to conduct more efficient programs.

1.2 The Three Vitamin A Interventions

The Guatemalan vitamin A programs analyzed in this report are examples of the three most common interventions implemented in developing countries to combat vitamin A deficiency--fortification, supplementation and dietary change. The programs are:

i) fortification of sugar for domestic consumption, a public-private collaborative effort of the Government of Guatemala and the Guatemalan sugar industry;

ii) oral supplements--capsules--distributed in collaboration with the government health care delivery system to young children and women of reproductive age in a geographically delimited, high prevalence area; and

iii) promotion of vegetable production and consumption by an agricultural extension program targeted to a region with widespread chronic vitamin A dietary deficit.

Each of the programs has been in operation for more than three years. One year--1991--was chosen for this study, a year in which all three programs had stabilized and for which adequate data could be obtained. The activities in that year were costed out, and the impact of the resources invested measured.

The sugar fortification program reaches the vast majority of the national population--only about 5 percent of Guatemalans are thought not to purchase and consume commercially processed sugar, with another equally small proportion of the national population consuming commercially purchased sugar, which is processed outside of Guatemala and is not fortified.

The capsule and gardens programs are implemented in two departments (states)--Quetzaltenango and San Marcos--both of which have a high prevalence of vitamin A deficiency. Of several private voluntary organizations implementing these programs, those of Project HOPE were selected for analysis because of both their longer track record and their interest in collaborating in the study. An overview of the three intervention programs analyzed in this study is presented in Table 1.

1.3 How Effectiveness Was Measured

Measuring the effectiveness of an intervention involves making an assessment of the intervention's ability to produce a specified, desired effect. The desired result of a vitamin

A intervention is to reduce the health consequences of inadequate vitamin A intake by improving the vitamin A status of the program's intended population.

To measure directly the changes in serum vitamin A, clinical signs of the deficiency or vitamin A liver stores resulting from the interventions analyzed would require substantial and costly field research. Because this study aimed, amongst other things, to demonstrate that cost-effectiveness analysis could be performed without having to devote large amounts of scarce resources and time to original data collection, the study focussed on suitable effectiveness indicators which could be estimated with available data.

Information on direct outputs--fortified sugar, distributed vitamin A capsules, and new vegetable gardens--were readily available, but could not themselves be used as effectiveness indicators since they were different for each program and could not be directly compared. Two indirect effectiveness indicators were developed:

i) a simple coverage estimate--"persons reached"--(defined as the total number of individuals reached by the intervention, regardless of their need for vitamin A); and

ii) a measure of the program's impact--"number of person years of vitamin A gap eliminated by the program"--(defined as the total number of years for which individuals living in households with inadequate access to vitamin A, fill their daily needs as a result of the intervention)[1].

The specific way in which this latter indicator was measured differed between the programs depending on the nature of the data available (see methodology details in Chapters 2, 3 and 4), but the overall approach was the same. It consisted of estimating:

i) which of the persons reached by the program were not otherwise receiving their full vitamin A requirements through natural sources; and

ii) how many of these **potential** beneficiaries achieved adequate vitamin A levels as a result of the program (and thus became actual beneficiaries) and for how many years. For each intervention this is some function of the amount of the "output" (e.g., fortified sugar consumed, vitamin A capsules distributed, and gardens planted). The strength of that relationship is well established for supplements and fortification, and less so for gardens and nutrition education, for which systematic evaluations are lacking (Arroyave et al., 1979; Muhilal et al., 1991; Beaton et al., 1993; Sommer, 1982).

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[1] The use of an alternate indicator such as "microgram of vitamin A transferred" was considered unsatisfactory for this analysis as the objective of the national strategy is to alleviate the risk of vitamin A deficiency in population groups, not to transfer micrograms of vitamin A per se.

Because women of child-bearing age and children less than 6 years of age, who comprise about 23% and 21% of the Guatemalan population, respectively (United Nations, 1991), are especially vulnerable to vitamin A deficiency, we were particularly interested in how efficiently this high-risk group was served by each of the interventions. We therefore complemented the two basic effectiveness measures with two more specific ones:

i) the number of **high risk** persons reached, and

ii) the number of **high risk** person years of vitamin A gap eliminated by the intervention,

where "high risk" refers to women of child-bearing age and children less than 6 years of age.

Other effectiveness-related terms we use in this report include: "target"--any individual with inadequate levels of vitamin A from natural sources; and "beneficiary"--any target individual who achieves adequate levels of vitamin A as a result of the intervention.

Where available data were not firm, additional analyses were performed varying key assumptions to see if these altered the overall conclusions. By more closely examining a few of the assumed causal linkages between program activities and behavioral impact, these simple sensitivity analyses provide some insight into the degree of confidence that one might have in the general results of this study. They also provide important information for future improvements in the design, management and performance of the interventions.

1.4 How Cost Was Measured

The aim of the costing exercise was to measure the annual costs of maintaining each of the programs. To do this, the nature of activities being undertaken routinely by the programs in the year selected for the study--1991--were identified and costed out using two broad categories of costs: recurrent and capital. Activities which were conducted in the earlier start-up phase of the programs but not continued (e.g., baseline studies, preliminary research) were not included in the cost estimates since our primary focus was on understanding how efficiently the current programs are, given that they have been established[2].

For recurrent costs, estimates were largely drawn from expenditure records. Where these records were not sufficiently comprehensive, detailed or reliable, costs were calculated from data on the quantities of inputs (obtained from inventory records) and the unit prices (either local or international prices, depending on the source of the inputs). This was the approach used in the case of donated goods such as the capsules and seeds. For capital goods, the major items in use were listed and their price and useful length of life determined. The value

[2] Furthermore, for some interventions, data were not available, and for an intervention of any reasonable length, these costs, when annuitized, would become in any case very small.

of capital goods was converted into an equivalent annual value using a discount rate of 10%. Costs to the consumer were not included in any of the estimates.

Costs have been expressed in US$ 1991, using official exchange rates to convert from local currency and using a discount rate of 10% to express costs from other years in 1991 terms. The data were largely obtained from donor, implementing and collaborating agencies during a field trip by two members of our team who visited Guatemala in early 1992.

Chapters 2, 3, and 4 discuss the three interventions in turn under the following headings: (i) overview of the intervention, (ii) program organization, (iii) effectiveness, and (iv) costs. The respective discussions of costs and effectiveness describe the particular methodology employed to analyze each intervention. Chapter 5 brings together the cost-effectiveness analyses of all three interventions and discusses them in the context of other programmatic and policy issues.

2.0 THE EFFECTIVENESS AND COSTS OF THE SUGAR FORTIFICATION PROGRAM

2.1 Overview of the Intervention

Sugar fortification, the foundation of Guatemala's vitamin A strategy, was initiated in the country in the late 1970s, temporarily interrupted in the early 1980s, and re-established in 1987. Guatemalan law requires that all sugar that is processed and marketed for direct household consumption in the country be fortified with vitamin A.

The legislation establishing the program specifies that fortified sugar must contain 15 μg of vitamin A per gram of sugar. This level was based on the results of Guatemalan dietary surveys which showed that on average young children consumed at a minimum 20 grams of sugar per day (Arroyave et al, 1979), and the WHO/FAO recommended daily intake (RDI) level of 300 μg for preschool children. In setting the level at 15 μg per gram of sugar, it was assumed that sugar should provide 100 percent of the daily recommended intake. While the RDI was subsequently revised (FAO/WHO, 1988) to 400 μg, the level specified by law for sugar fortification in Guatemala has not been altered.

2.2 Program Organization

The law mandating sugar fortification also specifies the roles and responsibilities of the four public and private institutions involved in the program:

- the Guatemalan Sugar Producers' Association (ASAZGUA),
- the Ministry of Health's Department of Registry and Control of Foods (DRCA),
- the Ministry of Health's Unified Laboratory for Control of Food and Medicines (LUCAM), and
- the Guatemalan Commission for Norms (COGUANOR).

ASAZGUA is responsible for preparing the fortificant and supervising the fortification process in all 17 of Guatemala's privately owned and operated sugar refineries. The fortification process uses a premix which consists of a small amount of sugar, an adhering agent (vegetable oil), the vitamin, and an anti-oxidant. ASAZGUA's responsibilities are: (i) to prepare the premix (which it does at a single location), (ii) to distribute the premix to each of 17 refineries which are located throughout the country, (iii) to supervise the mixing of premix with the refined, bulk sugar at each refinery, and (iv) to monitor the sugar fortification process at each refinery. The monitoring process is rudimentary and cannot be regarded as a quality assurance program. It consists simply of tracking the stocks and flows of bags of premix, without any closer scrutiny of the vitamin A content of the sugar.

ASAZGUA does send samples of the pre-mix to INCAP (Institute of Nutrition of Central America and Panama) for calibration of vitamin A levels in each batch of pre-mix.

At the national level, the monitoring of the fortification program is the responsibility of the Ministry of Health's DRCA. DRCA inspectors are expected to regularly collect samples of fortified sugar at each refinery and at retail outlets where sugar is sold. The law requires that these samples be analyzed at the LUCAM and that records of the results be maintained in confidential files of the DRCA. DRCA has the authority to issue warnings and to levy fines on refineries if the vitamin A content is not within $\pm$ 5 μg of the target level of 15μg of retinol per gram of sugar. However, no information was available about the number of samples analyzed by LUCAM, the number of violators identified, or the number of warnings and/or fines levied on violators.

COGUANOR is also charged by law with verifying sugar quality, including the level of fortification. COGUANOR, made up of representatives of both the government and industry, is authorized to levy fines where infractions are identified and remedial action is not taken. No details were available on the frequency, size or nature of any of COGUANOR's sugar fortification monitoring or enforcement activities.

INCAP, which developed the technology for fortifying sugar with vitamin A in 1970s, has played a role in providing technical support for the program in Guatemala and for promoting the expansion of the technique in the region.

2.3 Effectiveness of the Fortification Program

2.3.1 Persons Reached

While there are no firm data on what proportion of the population is reached by the sugar fortification program, it is generally believed to be close to 100%. Some geographically marginal groups (for example, near the border with Mexico) probably do not have access to fortified sugar. The population of Guatemala is 9.2 million with 1.93 million children under 6 and 2.12 million women of child-bearing age. If we adopt the conservative assumption that only 90 percent of the population is reached, this translates into 8.28 million persons or 3,643,200 high risk persons (1.9 million women and 1.74 million children) covered by the fortification program.

2.3.2 Person Years of Vitamin A Gap Eliminated

Since the impact of fortification is only felt in the year during which sugar is fortified, the number of person years of benefit is the same as the number of persons who switched from having inadequate to adequate levels of vitamin A in that year. This number is calculated in two steps by estimating: (i) the number of persons who were not receiving their vitamin A requirements through natural sources; and (ii) the number of these potential beneficiaries who actually reached adequate vitamin A levels as a result of the additional vitamin A consumed in fortified sugar.

Since we had no recent information about the distribution of vitamin A gaps and sugar consumption **within** households, the analysis was performed at household level. It was assumed that if a household, as a unit, did not have adequate vitamin A consumption, then all individuals within the household could meet their vitamin A needs and all of the young children and women of childbearing age (i.e., the high risk groups) within the household would consume the recommended level or more. An important basis for this assumption is data from dietary surveys and anthropological research showing a high consumption of sugar by young children in Guatemala.

The number of individuals whose vitamin A requirements were not met from natural sources. Estimates of the prevalence of vitamin A adequacy in Guatemala by INCAP (Arroyave, 1979), suggest that the upper 35% income category of households are consuming adequate vitamin A from natural sources. According to the national household expenditure survey, 37.6% (i.e., very close to 35%) of households (in which 33.7% of the population live) have incomes over 2,399 quetzales per year and are assumed to consume adequate vitamin A from natural sources. The remaining 66.3 percent of the national population, i.e., 6.1 million, are assumed to be vitamin A deficient without the fortification program. Of these, 1.4 million (i.e., 23%) would be women of child-bearing age and 1.3 million (i.e., 21%) children under 6 years of age, for a total of 2.7 million high risk potential beneficiaries or comprising 30 percent of all Guatemalans.

In order to assess the contribution of the fortification program to the vitamin A consumption of these potential beneficiaries (i.e., those with household incomes of less than 2,400 quetzales), it was necessary first to estimate the amount of sugar they consumed. Then, based on assumptions about the vitamin A content of the fortified sugar consumed, the amount of vitamin A provided from consuming fortified sugar was calculated. This quantity and the estimated quantity of vitamin A the household obtained from natural dietary sources was added and the resulting sum compared with the household's recommended daily intake (RDI). If the group mean was above 70% of this RDI[3] the group was considered to be no longer at risk of vitamin A deficiency and its members were counted among the sugar fortification program beneficiaries.

The quantity of fortified sugar consumed. Annual, average household sugar consumption was obtained from the 1979-80 national household expenditure survey (the most recent available at the time of analysis). These data, disaggregated by income and rural versus urban residence, are presented in Table 2.

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[3] The RDI's are highly conservative estimates of what the mean levels of vitamin A should be globally in order that all members have adequate intakes. Since we are dealing with a fairly homogeneous population in a single country it is reasonable to choose a somewhat less stringent criterion.

Vitamin A intake through sugar consumption. The true levels of vitamin A in fortified sugar at the point of consumption are not known with certainty. In this analysis we explore three different assumptions:

i) **that sugar is fortified at the level mandated by law (i.e., 15 μg per gram of sugar);**

ii) **that sugar is fortified at the levels found in a 1989 INCAP study.** INCAP analysis of sugar samples drawn from a number of commercial retail outlets and households located throughout the country in 1989 revealed that the vitamin A levels in fortified sugar were well below the legally mandated 15μg per gram of sugar (Dary & Cifuentes, 1991). Samples taken in urban areas were found on average to contain only 4.71 μg of vitamin A per gram of sugar, 31.4 percent of the legally required level. The corresponding figure for rural areas was an even lower 2.51 μg of vitamin A, or 16.7 percent of the required level.

iii) **that sugar is fortified at levels found in the 1992/93 INCAP study.** Efforts were made to improve the low levels of fortification found in 1989. As a recult, the average level of vitamin A per gram of sugar in households rose to about 7.3 μg in urban samples, and 6.0 μg in rural samples.

Table 2 describes the amount of vitamin A (in micrograms) consumed in sugar per household per day, by family income and urban-rural residence, for each of the above three scenarios. This was calculated by multiplying the average household sugar consumption levels by the assumed fortification level of sugar.

Recommended Daily Intakes (RDIs). The recommended daily intakes used in estimating the adequacy of the different households' vitamin A intakes and the households' assumed composition are presented in Table 3, based on data on the RDI per person (WHO/FAO, 1988) and the composition of households (United Nations, 1991).

The level of natural vitamin A intake by potential beneficiaries. Information on normal dietary intake of vitamin A is poor. Dietary surveys in rural areas suggest consumption from natural sources of 200 μg per capita (about 35% of recommended levels of vitamin A) (Arroyave et al., 1979). Combining this together with data on the size of rural and urban households with income less than 2400 quetzales, Table 3 gives the amount of vitamin A consumed from natural sources as 1140 μg (urban households) and 1150 μg (rural households).

It is likely that urban consumption of vitamin A from natural sources is somewhat higher but, as the following section shows, this would make no difference to our conclusions that the urban deficit is rectified for all three assumptions of vitamin A content of sugar. For this

analysis, we will thus work with the simple assumption that average consumption from natural sources is 200 μg for both urban and rural households.

The remaining vitamin A consumption gaps. To translate the above information on household **categories** into numbers of households and individuals it was necessary to have data on household numbers and size by income and place of residence. The 1979-80 national household expenditure survey did have data on the numbers of households in each broad income and rural/urban category. But this information needed to be updated because of the significant demographic changes that have occurred in the past 10 years, notably the growth in the population and the shift from a predominantly rural to a predominantly urban distribution of households. Combining the 1987 Demographic and Health Survey (DHS) data on the rural-urban place of residence and average rural and urban household sizes, together with the U.S. Census Bureau's 1990 national population estimate of 9.2 million, enabled us to estimate the number of households in urban and in rural areas. Assuming the same percentage distribution within urban and within rural of households by income category as found in the 1979-80 national household expenditure survey, we were then able to develop an estimate of the number of households in each income category. These estimates are presented in Table 4.

Table 5 puts together the data described above and determines which households shift from insufficient to adequate vitamin A intake with fortified sugar under the three different scenarios of assumed levels of vitamin A in fortified sugar at the point of sale to households. The household's total vitamin A consumption was calculated as the sum of that obtained from eating fortified sugar and that obtained from other sources. This total is compared with the RDI's for each group.

> *Scenario 1:* Assuming 15 μg vitamin A/gram of sugar, all Guatemalans reached by the fortification program who had inadequate vitamin A intake prior to consuming any fortified sugar--that is, 90% of 6,106,974 vitamin A deficient Guatemalans (5,496,277 including 1,264,144 women and 1,154,218 children 5 years old or younger)--had their vitamin A gap eliminated by eating fortified sugar and thus are beneficiaries of the sugar fortification program. The minimal amount by which any of the household categories exceeds the vitamin A RDI is 51 percent--that of urban households with incomes of less than 1200 quetzales.

> *Scenario 2:* Based on vitamin A levels found in the 1989 study, the fortification program rectifies deficiencies in the low income urban but not the rural groups. If the 10% of individuals whom we assume are not reached by fortification are in the rural areas then, under this scenario, the fortification program provides protection to 264,781 urban households consisting of 1,509,251 persons of all ages, including 664,069 in high risk age groups (Table 4). Fifty percent of all households nationwide (i.e., all low income rural households), however, still consume insufficient vitamin A despite the fortification program--i.e., 70% or less than their RDIs--a level below which individuals are considered at high risk of vitamin A inadequacy. Despite the

fact that the urban income groups consume less sugar, they obtain more vitamin A from fortified sugar than do the rural groups with higher need, because of the higher concentration of vitamin A in urban sugar supplies.

Scenario 3: Assuming that the amount of vitamin A in a gram of sugar averages 7.3 μg, the situation looks markedly better, in fact as good as the first scenario: all deficient households reached by fortification achieve adequate vitamin A levels and 5.5 million individuals including 1.26 million women and 1.15 million children 5 years old or younger had their vitamin A gap eliminated by eating fortified sugar, Nevertheless, there is still reason to be concerned over the barely adequate results for the low income group which includes 25 percent of the national population, and nearly one-half million women of child-bearing age and about one million children less than 6 years of age, particularly when it is recalled that we have assumed in our calculations that intra-household sugar consumption is distributed in proportion to dietary need.

2.4 Costs of Fortification

The annual cost of the program in 1991 was US$2,379,278 (Table 6). An attempt was made to cost out all the activities of the fortification program described in section 2.2. For most recurrent costs, estimates were derived from detailed 1991 estimates of the expenses incurred by the government and the sugar industry. There has been little fluctuation in recent years in the quantity of Vitamin A purchased annually, suggesting that purchases fairly accurately reflect consumption and that stocks have not been run up or down.

The capital costs consist of the estimated market value of the measuring and mixing devices which were acquired in 1987-1988 in order to restart the program. The relatively minor expenditures required to undertake advocacy and to the issuing of directives for the re-implementation of the program on a national scale have been excluded. These estimates do not include the initial investment made 15 years ago when preliminary technological development and consumer acceptability tests were first undertaken by INCAP. This technology has subsequently been applied in several countries.

3.0 THE EFFECTIVENESS AND COSTS OF CAPSULE DISTRIBUTION

3.1 Overview of the Intervention

Project HOPE is a private, non-profit organization that has been assisting the Guatemalan Ministry of Health (MOH) to deliver basic health services in the Departments of Quetzaltenango and San Marcos since 1976. Starting in September 1990, Project HOPE added vitamin A supplementation through capsule distribution to its program of activities in the two departments, aided by financing from a USAID grant, technical assistance from INCAP, and the collaboration of the MOH. This activity was initiated in response to indications that the sugar fortification program was not effectively reaching all segments of the population and that geographically targeted supplement programs were needed to provide immediate coverage in communities with a high prevalence of vitamin A deficiency.

The project originally covered all 53 municipalities in the two departments (total population 1,229,793). A baseline survey conducted as part of the project found that 24 municipalities had particularly high prevalence of vitamin A deficiency: of a sample of more than 3,000 children, 30 percent in 12 municipalities of Quetzaltenango and 28 percent in 12 municipalities San Marcos were found to have low serum retinol levels (Project HOPE Mid-Term Evaluation Report, 1992). Since serum retinol is a measure towards the severe end of the spectrum of deficiency, these data suggest that most of the population have inadequate vitamin A intakes. This finding prompted narrowing of the focus of the project in 1991, which thereafter provided vitamin A intervention services exclusively to these 24 municipalities.

The goal of the project is to distribute (within the 24 municipality area) high-dose vitamin A capsules once every six months to all children 6 to 72 months of age and (as recommended by WHO/UNICEF/IVACG, 1988) to all new mothers within four weeks of giving birth. Project HOPE staff estimate that in 1990-91 there were 83,619 families, 501,714 individuals and 96,075 children less than six years of age residing in the 24 target municipalities, and that each year there are 21,146 births, and thus 21,146 postpartum women.

The rapid evolution of the project during the study period from generalized distribution to a more targetted one creates some uncertainties regarding the coverage and costs of a mature program. The capsule distribution moved out of its start-up mode into what the staff regard as a more permanent phase of "normal operations" (with more established responsibilities and routines) in the start of its second year in September of 1991, the beginning of Project HOPE's fiscal year. September 1991-August 1992 was therefore selected as the time period for which cost and effectiveness would be estimated.

3.2 Program Organization

Project HOPE is responsible for: (1) program planning and coordination, (2) training MOH staff, traditional birth attendants (TBAs) and midwives in capsule distribution, and (3) providing the vitamin A capsules to be distributed. In addition, HOPE staff conducted the baseline survey. Since its inception, the project has distributed vitamin A supplements in collaboration with the MOH. MOH teams trained by Project HOPE staff accompany them to health posts, centers, and communities during distribution of the vitamin A supplements. Of the 71 MOH staff who work in the targeted communities, by mid-1992, nearly two-thirds had been trained by HOPE personnel. The trainees included 11 physicians, 11 nurses, and 23 auxiliary nurses and rural health technicians. A number of community-level promoters, TBAs, midwives and volunteers have also been trained.

Capsule supplies for the first distribution were obtained by Project HOPE from in-country stocks, supplemented by a donation from Helen Keller International (HKI). In 1992, a private foundation, Sight and Life, donated additional capsules. HOPE began implementing a planned expansion of the supplement distribution to the neighboring Department of Totonicopan in 1993, while maintaining the program in Quetzaltenango and San Marcos.

3.2.1 Child Component

In the component of the project geared towards children, capsules are distributed twice a year at MOH health posts, health centers, and communities. Children from six months to one year of age are given capsules of 100,000 International Units (IU) of vitamin A. Children from one to six years old received 200,000 IU capsules. The size and timing of the supplements reflects the fact that vitamin A can be stored in the body for up to 6 months and that this frequency of distribution is necessary in order to maintain circulating vitamin A levels.

Project HOPE obtains capsule supplies and provides them to MOH facilities. In addition to distributions at these facilities, rural communities are visited on scheduled days by Project HOPE and MOH staff. Project HOPE provides transportation for these visits. To increase awareness of the purpose and timing of the distributions, and to promote participation, radio announcements of upcoming vitamin A distributions were conducted in 3 local dialects prior to the distribution. One to two months prior to the event, rural health workers were reminded of the forthcoming distribution and instructed to so inform the communities they serve as well. Generally MOH staff take advantage of the capsule distribution days to also provide immunizations.

3.2.2 New Mothers Component

The component of the project targeting new mothers relies to a significant extent on TBAs and midwives. The project trains both TBAs and midwives, and by mid-1992 some 193, or about one-third of the approximately 600 TBAs working in the project communities, had been trained by Project HOPE.

The TBAs and midwives who have been trained receive an initial supply of 10 capsules for one month, and then return monthly with the balance of capsules for replenishment and to report the number of post-partum women to whom they have distributed vitamin A. Capsules are procured by Project HOPE and provided to TBAs and MOH staff who train, supervise and re-supply the TBAs. The project distributes supplements only to those mothers who are in their first four weeks post-partum. The likelihood of conception during this period is remote, and the practice of so limiting the target women's population, which is in accordance with WHO guidelines, is intended to avoid the danger of teratogenic effects of high doses during fetal development.

3.3 Effectiveness of Capsule Distribution

3.3.1 Persons Reached

Children: In October of 1991, during the first, children-targeted vitamin A campaign, approximately 300,000 capsules were provided to health facilities and distributed to children in all 53 municipalities of San Marcos and Quetzaltenango. A second, more targeted campaign in 24 municipalities was held in April of 1992. Slightly more than 100,000 capsules were distributed to children directly and provided to health facilities. Project records indicate that the coverage level with this second campaign was approximately 45 percent but varied markedly across the 24 target communities, ranging from 19 percent to 71 percent in Quetzaltenango and 23 percent to 83 percent in San Marcos (Project HOPE Mid-Term Evaluation, November 1992). From Project HOPE records it was determined that this second campaign covered 42,756 children in the desired age group of 6-72 months.

Mothers: Data on the number of doses actually given to post-partum women were not available. From discussions with field personnel, however, it was estimated that roughly 30 percent of the TBAs in the program communities have received training, and that they provided capsules to approximately 20 percent of all post-partum women (4,200 of 21,146 births) during the year.

Children and mothers: An estimated total of 46,956 (42,756 + 4,200) persons were reached with at least one dose.

3.3.2 Person Years of Vitamin A Gap Eliminated

No data are available for determining the number or proportion of targeted children (6-72 months of age) who actually received both doses of vitamin A in each of the two campaigns. Assuming that 80% of those children who were covered in the second campaign also received the first dose, brings the estimated number of children provided two doses to 34,205.

Assuming (i) that all individuals in the area had inadequate vitamin A intake from natural sources (high vitamin A deficiency was indeed why the area was targeted); and (ii) that adequate protection for one year is provided by two capsules at 6-monthly intervals for children 6-72 months of age and by one dose given within 4 weeks postpartum for mothers, then the number of person years of vitamin A gap eliminated by the capsule distribution is therefore 38,405 (34,205 + 4,200). If we assume that those children receiving only one dose receive 6 months protection (rather than the zero protection assumed above) this becomes 42,681 (4,200 + 34,205 + 8,552/2) years of protection.

Since capsules were highly targeted to mothers and young children, the number of high-risk beneficiaries would be close in value to the number of beneficiaries, and indeed for this analysis we will assume that they are exactly the same.

3.4 Costs of Capsule Distribution

The costs of all the activities described in section 3.2 were estimated (except for the cost of broadcasting messages, a service provided free). The estimated administrative costs of the project include reporting requirements for the USAID child survival grants program--one of the institutions partially financing the activity--and prorated shares of Project HOPE and MOH staff time reflecting the costs of training, supervision, and field clinics.

Total annual costs incurred during September 1991-August 1992 came to US$71,556 (summarized in Table 7 and disaggregated by funding source in Annex 2). The costs of the two principal recurrent cost categories--personnel and transportation--represent about two-thirds of the total recurrent costs of the project. The imputed cost of capsule supplements (based on the numbers distributed, not numbers reaching their target) which Project HOPE received as a donation represents approximately 11 percent of the overall program costs and roughly 12 percent of recurrent costs. In part because the vitamin A supplement distribution activity is an add-on to an existing project, this intervention has relatively low capital costs for motorcycles and office equipment for managing and monitoring the program.

4.0 THE EFFECTIVENESS AND COSTS OF THE GARDENING AND NUTRITION EDUCATION INTERVENTION

4.1 Overview of the Intervention

Project HOPE supports not only vitamin A capsule distribution, but also--in collaboration with the Directorate General of Agricultural Services of the Ministry of Agriculture (DIGESA), the Ministry of Education (MOE), and other entities such as the Peace Corps--provides donated seeds, extension services and nutrition education, designed amongst other purposes to increase vitamin A intake. The geographic areas in which it works are the same high vitamin A deficiency prevalence municipalities in which capsules are being distributed now that the capsule program is more targeted (24 municipalities of Quetzaltenango and San Marcos).

Participants in the garden and nutrition education project include families, schools and communities. Participants provide the land, labor, water, fertilizer and pesticides for the gardening component of the project. The project provides seeds and agronomic technical assistance, without obligation on the part of the project beneficiaries to donate any part of the produce.

The goal of the project is to increase the cultivation of gardens and the production and consumption of vegetables. Vegetables from the gardens and other sources are expected to provide their producers with sufficient vitamin A to meet their recommended daily intakes.

4.2 Program Organization

Project HOPE staff train the trainers; they teach MOE, DIGESA and other community organizations' staff about vitamin A's nutritional significance and how to produce foods rich in vitamin A. An estimated 91 technicians of DIGESA had been trained by mid-1992. Project HOPE agronomists also participate directly with a DIGESA team in the training and supervision of the community and family garden promotion. The DIGESA team is comprised of an agricultural extension agent, a home educator, an assistant extension agent and five agricultural representatives. The DIGESA team is itinerant and assigned to cover 14 of the 24 municipalities, with a Project HOPE team covering the remaining 10. Each of the 24 municipalities has a community liaison who represents the community, communicating and working directly with the DIGESA or HOPE team.

Project HOPE staff also serve as resource persons for teachers who are responsible for supervision of the school gardens and for DIGESA home educators who provide nutrition education to the participating families.

Community workers and agricultural extension agents serve as the trainers in the nutrition education component of the project. The existing approach has been to rely on group and one-on-one oral presentations. Mass media and printed literature have not been used.

The major monitoring activity of the project is tracking the number of households receiving seeds and initiating gardens, which is the primary outcome indicator of both the garden and nutrition components of the project. The number of households receiving inputs was 3,992 in 1991 and 7,735 in 1992, but in 1993 declined to 4,815 when Project HOPE began handing over direct extension education activities to other agencies in the area and reducing its inputs. It took a year for the project to get established and function smoothly and by the third year HOPE's involvement was reduced. The middle year--September 1991 to August 1992--was chosen as the period for which costs and effectiveness would be measured.

4.3 Effectiveness of Gardens and Nutrition Education

Results of an evaluation, conducted in September 1993--2.5 years after program implementation began--provide the basic data for generating effectiveness estimates. The evaluation included a formal survey as well as informal focus group discussions. In the formal survey, 300 households in the two project departments--San Marcos and Quetzaltenango--and 300 households in an adjacent non-project department--Totonicapan--were randomly selected and data gathered on the production and consumption of vitamin A containing foods. Interviews were conducted with women in the households by teams familiar with the local languages. Interviewer teams were trained and supervised by an external evaluator.

Households in the project and control areas tended to vary on some socio-economic criteria. The majority of household heads in the project area, unlike the control area, were engaged in agricultural activities (though this was not felt by those who know the area to be significant in determining whether a household had a garden). Project households were more likely to have a corrugated iron roof, own more livestock and have more educated women, but they were less likely to have electricity and own possessions such as radios, televisions and bicycles than non-project households. Other characteristics were similar across control and program households.

4.3.1 Persons Reached

7,735 gardens were provided with inputs by Project HOPE in 1991/2. The average household size in the area was found by the evaluation to be 6.9 for a total of 53,372[4] persons of all ages reached by the program, of which 23,483 are in high risk categories.

4.3.2 Number of Person Years of Vitamin A Gap Eliminated

This indicator was calculated by first estimating the number of gardens established by the program, the length of time for which they functioned and the number of individuals who benefitted. This information was put together with assumptions concerning the number of

[4] The number of school and community gardens serving more than one household was small.

individuals with inadequate intake of vitamin A before the gardens were established and the level of vitamin A intake from the gardens.

The number of person years of access to gardens established by the project. The number of gardens established was calculated from Project HOPE's records of the number of households provided with inputs and making two modifications based on the following observations: (i) approximately 10% of the households which had been provided with project inputs were found by the evaluation not to have functioning gardens in the project area; and (ii) three percent of households in the control area (i.e., without any program support) were found to have functioning gardens, implying that a similar proportion of households in the program area may have had gardens prior to the initiation of the program. The total number of gardens established during the study period (1992) was therefore calculated to be 6,753 (7,735 * 0.9 * 0.97). On the assumption that each garden served one family (an average of 6.9 individuals), this translates into 46,596 potential beneficiaries or 20,502 high risk potential beneficiaries.

If the garden only functions during the period for which inputs are provided, these figures also measure the number of person years of potential benefit from each garden. It seems likely, however, that gardens will continue for some time after external inputs are provided although, unfortunately, we have no firm data on this. Table 8 illustrates how the number of beneficiaries might look under two different assumptions of the long-term effects generated from three years of investment. Dividing these figures by three gives annual discounted beneficiaries as 71,613 (31,510 high risk beneficiaries) for scenario A and 56,847 (25,013 high risk) for scenario B.

It should be noted that counting only the gardens initiated with Project HOPE's inputs probably underestimates the eventual impact of the gardening intervention in the 24 target municipalities, since it is a well-documented phenomenon in agriculture that successful changes are often introduced by a small group of innovators and then gradually diffused through the community by neighbors observing and eventually copying what the innovators do. This phenomenon has been observed in gardening interventions in Chile and in some U.S. urban settings. It is possible in Guatemala that additional gardens may have been started after the initial ones were created with HOPE support, through natural diffusion of the gardening "innovation".

Pre-project levels of vitamin A insufficiency. Given that 24 communities with the highest prevalence of low serum vitamin A were targeted for this program, we assume for this analysis that ALL children and women in the program areas selected to receive these inputs had inadequate vitamin A intakes prior to the program.

The amount of Vitamin A consumed from gardens. Vitamin A consumption from gardens depends on (i) whether vitamin A rich vegetables are planted, and (ii) to what extent the gardens contributed to the consumption of such vegetables.

The two best plant sources of vitamin A are dark green leafy vegetables (DGLVs)--chard, spinach, mustard leaves and radish leaves--and carrots. Ninety-three percent of project households had planted at least one DGLV in their home garden in addition to carrots, other vegetables, or herbs in the preceding planting season; the comparative figure for non-project households was only one percent.

The household survey found that close to 95 percent of the project households had eaten DGLVs in the preceding week, while only one-third of non-project households had done so. Among the households that consumed vegetables in the preceding week, over one-half of the project households obtained DGLVs from the home garden or farm, while fewer than 15 percent of non-project households did so; most were buying their DGLVs in the market.

The number of days on which food sources of vitamin A were consumed in the project area was significantly higher than in the non-project area. This was particularly true of foods rich in vitamin A namely, broccoli, DGLVs, tomatoes as well as eggs, fresh milk and fresh cheese. A consumption index (CI) was developed (IVACG, 1989) for each child under the age of six years based on the number of portions of vitamin A containing foods eaten during the previous 24 hours. Multivariate analyses showed that children age 6-11 months, children whose mothers have not been to school, children from households that get their water from a well or open-air sources, as well as children from the non-project households who did not plant or harvest DGLVs were at significantly greater risk of having a low CI. Indeed, children from households in the non-project area that did not plant or harvest DGLVs were at over three and one-half times greater risk of having a low CI even after the effects of child age and socio-economic status were removed.

Data collected on knowledge of the importance of vitamin A in the diet and awareness of food sources of vitamin A tended to support the consumption data. One-quarter of mothers in the non-project area were not able to state why vitamin A is important in the diet, which was three times the level for the project area. In addition, one-quarter of mothers in the non-project area did not know any food sources of vitamin A, which was double the level found in project areas.

Based on the consistency of evidence regarding the impact of the gardens (greater availability of vitamin A foods, improved knowledge and awareness of mothers, and improved consumption of vitamin A foods by children) we conclude that this program resulted in a significant increase in vitamin A intake for those with gardens, enough that these individuals reached adequate vitamin A levels.

Vitamin A gap reduction. Since we have assumed that ALL children and women in the program areas had inadequate vitamin A intakes prior to the program and that those participating in the program all received sufficient vitamin A to compensate, we conclude that all those served by functioning gardens achieved adequate vitamin A intakes as a result.

This may in fact represent a conservative estimate as the evaluation did not include households in the program area without gardens, and it is possible that the nutrition education effects actually resulted in a larger number of high risk persons achieving adequacy in vitamin A intakes if some households used vitamin A rich foods purchased from the market or wild greens from their farms to enrich their diets.

4.4 Costs of Gardens and Nutrition Education

The annual costs for 1991/2, which is the sum of annuitized capital costs plus recurrent costs were estimated at US$85,284 (Table 9). The seeds used for the agricultural extension program have been donated by a private firm. Their imputed cost (based on the commercial value of the seed) represents 12 percent of the overall project cost and 16 percent of the annual recurrent costs. Personnel costs account for somewhat less than half (44 percent) of annual recurrent costs and include portions of the salaries of HOPE administrators, the project agronomists, and the extension agents. The major components of the operations and maintenance costs of this project are travel expenses of the project agronomists and extension agents working directly with families, all of whom travel between the 24 communities, and the logistics support provided to Ministry of Agriculture (DIGESA) staff. DIGESA staff costs and a proportion of the salaries of teachers involved in school gardens (Ministry of Education) are included, as described in Annex 4.

As in the case of the sugar fortification and capsule distribution programs, the capital costs of this program are relatively low. Significant portions of this program are undertaken jointly with Project HOPE's capsule distribution program (see Annex 4 for details of how joint costs were allocated across these two intervention).

Although some other studies of the cost-effectiveness of garden promotion have included the costs of participants and found them to be large (Popkin et al., 1980), we did not measure participant costs in this study for the following reasons. First, they are difficult to determine with accuracy. Second, we do not have them for the other interventions (where, admittedly, they are probably less important). Third, in this geographic area, where the size of gardens is small and alternative employment for women limited (except in certain lowland communities), the opportunity cost of women's labor appears to be offset by income saved due to less quantities of vegetables purchased. In the focus groups, women stated the main benefit of gardens was saving them time and money as they do not have to purchase vegetables from the market. In the sample survey, 60% of the respondents gave this as their first answer to the question on garden benefits.

5.0 COST-EFFECTIVENESS ANALYSIS OF THE THREE PROGRAMS: FINDINGS AND POLICY IMPLICATIONS

This chapter brings together the separate analyses of the costs and effectiveness of each of the interventions to explore the relative efficiencies of the three approaches.

5.1. Cost-Effectiveness Estimates of the Three Interventions

Tables 10 and 11 provide a summary of the effectiveness and costs, respectively, of the three interventions drawn from Chapters 2, 3 and 4. Table 12 combines the information from Tables 10 and 11 to generate cost-effectiveness estimates for each of the three interventions.

Because fortification is basically untargetted in terms of age and sex, cost-effectiveness expressed in terms of high risk groups is considerably less attractive compared with using the whole population as the denominator--130% more costly per effectiveness unit. Capsule distribution on the other hand, is directly targeted to these groups (i.e., the cost per person and the cost per high-risk person are the same).

Similarly, because fortification reaches individuals regardless of their need for vitamin A, there is a large difference in the cost-effectiveness when expressed in simple coverage terms ("per person reached") as opposed to impact units ("per person whose vitamin A gap was eliminated"). The gardens and capsules programs, on the other hand, have been focussed in identified needy areas so that the difference between cost per "person reached" and cost per "person whose vitamin A gap was eliminated" is small.

Despite these elements of "waste", the fortification program continues to look like an attractive option even when the measure is the highly specific "cost per high-risk person whose vitamin A gap was eliminated". The very low costs of distributing the fortificant through sugar more than compensate for the fact that a quite substantial amount of the vitamin A reaches consumers who do not need it.

The only scenario where fortification appears to be less attractive than the other alternatives is for that of low fortification levels expressed in terms of cost per high risk person whose vitamin A deficiency has been eliminated. It seems likely that the costs estimated in 1991 were for a program which was responsible for achieving the improvements over these low 1989 results (i.e., for the medium vitamin A level). If this is indeed the case, fortification is certainly a competitive alternative.

There are strong reasons for suspecting that the fortification program has been highly inefficient in the past. In 1989, when very low levels of fortificant were detected in sugar, substantial quantities of vitamin A were imported. Indeed the quantity imported has remained roughly the same since the late 1980s. The costs involved in the additional monitoring and quality control which presumably led to improvements in fortification at point of consumption appear to be extremely small (nearly 97% the cost is for the fortificant), which suggests that at that time the cost-effectiveness of the program was about the level indicated in our scenario #1 (i.e., more than 3 times as costly per unit of impact on vitamin deficiency). Clearly care needs to be taken to ensure that this situation does not reoccur.

There are also reasons for believing that the fortification program has not yet fully exploited its potential for improving the efficiency of its operations. The quantity of vitamin A being imported is sufficient to achieve levels of sugar fortification at the legally mandated level ($15\mu g$ per gram of sugar) at the point of production. Since even the more optimistic estimates indicate that the levels are on average only half this it appears that the substantial cost of the vitamin A is being frittered away. Since the technology for ensuring adequate fortification to the level of sale is not complicated or expensive, and neither is that for monitoring (inexpensive field techniques for monitoring vitamin A content have been developed by INCAP), it would appear to be highly cost-effective to increase the amount of resources devoted to these activities. Furthermore, since the legally mandated levels of fortification appear to offer few additional benefits over a more modest level (about half that legally mandated), reducing the amount of fortificant purchased would, when good monitoring and quality control efforts are in place, appear to be a sensible strategy. In other words, it would seem to be quite possible to reduce overall costs while maintaining or even increasing effectiveness.

5.2 Applying the Cost-effectiveness Estimates to Modifications of the Interventions

The findings of the analysis presented above are based on historical data and describe the cost-effectiveness of these interventions as they were functioning in the year for which they were studied. Two potential problems emerge as a result: (i) first, direct comparisons between the three interventions are difficult since they do not have either the same level of costs or the same level of effectiveness--sugar fortification has a larger cost and a larger impact than the other two--and in such cases cost-effectiveness analysis on its own cannot judge which is the most efficient; and (ii) the specific options that have been studied may not be precisely those being considered by decision-makers for future investment (they may be larger, smaller, more or less targeted, etc.). It is, therefore, important to go beyond the basic cost-effectiveness numbers we have generated and interpret the results in the light of the specific circumstances in Guatemala.

5.2.1 Which Is the Most Efficient National Level Program?

An important question in the Guatemalan context might be: "Would the amount of resources currently being invested in fortification achieve better results if invested in supplementation or gardens?" While the cost-effectiveness results we have presented do not directly provide the answer, they do give some clues.

Capsules: The cost per unit of impact on vitamin A is higher for the supplements than for the fortification program. What would happen to the cost-effectiveness ratio if the supplements program were to expand to national level is difficult to predict. The program is currently conducted in difficult-to-access costly-to-reach areas: the program population lives in 24, scattered, dispersed, relatively inaccessible, high risk municipalities of Quetzaltenango and San Marcos. Expanding coverage (i.e., to more densely populated accessible areas), perhaps could be done for lower average costs than the supplements program currently experiences.

On the other hand, the current capsule distribution program is highly targetted, which helps its effectiveness. Expanding the program might mean that either the costs of targeting would go up or the impact on vitamin A would fall. The feasibility of expanding capsule distribution by replicating the HOPE model and maintaining it at high coverage levels is questioned by authorities familiar with the health system infrastructure in Guatemala: the replication would be a substantial one--far less than 100,000 persons at best are reached by the current capsule program, compared to the fortification intervention's 4 to 6 million people. As presently configured and given the program's current coverage, it would require at least 40 to 60 capsule-based intervention projects to achieve the same impact as the fortification intervention.

Gardens: Participation in the gardens program requires considerable effort on the part of the households. The result is that only those most easily motivated remain in the program, i.e., there is a substantial amount of self-selection. There would be similarly interested individuals elsewhere who might as readily take up gardens but expansion of the program beyond this self-selected group is likely to be difficult and require relatively substantial effort with the result that average costs would eventually rise. Even adopting a fairly optimistic assumption about the continuation of these gardens and improvements in the management of the program, it seems highly unlikely that education and gardening would be a viable approach nationally.

5.2.2 How to Most Efficiently Reach the Vulnerable Geographic Groups?

Another important question in Guatemala (which could in principle be answered by cost-effectiveness analysis) is likely to be: "How can the vitamin A deficiencies of those vulnerable communities currently being targeted by the gardens and capsule programs, be most efficiently rectified?" Direct comparisons between the gardens and the capsule programs, which are of a similar scale and cost, indicate that the two are similarly efficient at removing deficiencies in the population at large, while capsules have the edge when removing deficiencies in high-risk individuals is the goal. The extent to which an established garden will continue once inputs are withdrawn clearly makes a large difference to the cost-effectiveness of this program. More optimistic assumptions than we have used could easily make gardens a more cost-effective approach than capsules. This is an area where better information is required.

There appears to exist some potential for improving the efficiency of the capsule program in the area. Closer monitoring of what happens to the distributed capsules might help to reduce costs or increase effectiveness--some 50% of the capsules (or approximately 50,000) do not appear to have reached their targets. Discussions with the project managers suggest that coverage in the area might be increased some 50% with relatively little additional costs by taking advantage of the fixed costs of village visits to more effectively promote the program. Achieving higher coverage than this would appear to be difficult. The capsules are distributed through local Ministry of Health facilities, whose coverage throughout most of the targeted geographic area is limited to an estimated 30 to 40 percent of the population.

Only about 10% of local households have participated in the gardens project. Project HOPE reports a high demand for additional gardens suggesting that there is some scope for expansion in the immediate area. Ensuring that the quality of the seeds is high (to avoid the previously experienced problem of old seed not germinating and prompting the withdrawal of some households from the program) and exploring other media for promoting gardens perhaps by making use of radio, to which many in the communities listen, may be strategies which could increase coverage cost-effectively, perhaps even at lower average costs than the current program.

Sugar fortification has not been a successful strategy for removing vitamin A deficiency in these areas. However, before ruling it out as a potential vehicle for reaching these vulnerable groups, it is worth exploring the reasons why it has not been successful. Three broad explanations are possible: (i) that the population does not consume much sugar; (ii) that the sugar consumed is not the type of sugar which is being fortified ; or (iii) the level of fortification in the sugar is low. If the first two explanations hold, the potential role of fortified sugar is clearly limited--promoting an increase in consumption of a commodity like sugar with some deleterious health effects is unlikely to be viewed as an appropriate strategy for a health ministry, and attempting to fortify currently unfortified sugars or limit the consumption of unfortified sugars is likely to be a difficult and therefore unattractive option.

In fact, however, there is little reason for believing that the explanation lies in either low sugar consumption (national surveys indicate that sugar consumption is quite uniformly high throughout the country, as documented in Arroyave et al. 1979) or consumption of unfortified sugar (Project HOPE's baseline survey found the sugar to be fortified, if at very low levels). We have found no evidence to suggest that access to fortified sugar is a problem. In other words, there appears to be some scope for employing the vehicle of fortification to rectify low vitamin A levels in these populations by improving the quality of fortification and ensuring that sugar fortified at adequate levels is reaching the consumer. Exactly how this might be done would need to be explored in the light of the way the fortification program is organized.

5.3 Comparisons with Previous CE Estimates of Vitamin A Interventions

The conclusions reached above as to the relative efficiencies of the 3 vitamin A interventions in Guatemala are not necessarily applicable to other countries with different socio-economic, cultural, ecological and geographic characteristics. Tilden and Grosse (1988) have demonstrated that the choice of a vitamin A strategy that is optimal for a given setting depends on the budget level available and on technical considerations such as what proportion of the population suffers from vitamin A deficiency and to what degree, how well defined that group is, and how easily it can be targeted (e.g., geographically, how uniform is consumption of a potential fortification product, etc.).

Table 13 compares the cost estimates per person reached in this study with those from previous country studies in the Philippines, Indonesia and Guatemala. To remove one, uninteresting source of interstudy difference, the costs of all the studies have been converted into 1991 US$. The effectiveness units of the Levin and Popkin studies have also been modified to make them comparable with ours, correcting for leakages to the general population by allocating the fortification costs to only 44% of the population (approximately the proportion of women of reproductive age and children under 6 years).

The cost-effectiveness of fortification is found to be somewhat higher for the recent Guatemala study compared with the other two. This might be due to differences in the degree of fortification (fortificant being the single most important cost of this program). Other factors which might be important determinants of cost-effectiveness for other types of interventions are not likely to be important here: these programs have relatively low levels of capital investment (i.e., scale makes very little difference to them), the level of targeting is similar and low, and the fortification process is quite centralized, with the result that geographic circumstances are largely irrelevant.

The capsule program examined in this study was considerably more costly per person reached than the other two capsule programs. In good part this is likely to be explained by the fact that the program is located in a geographically remote area with a scattered population in contrast to the densely populated and easily accessed populations where the Levin and Popkin estimates were developed.

The garden program in the Philippines was more expensive per person reached than that in our study. This is probably largely accounted for by methodological difference. In contrast with our estimates, the Philippines study included private costs, which amounted to 65% of the total costs. If these private costs are removed, the estimate falls to US$ 0.81, below the estimate of the garden intervention as currently implemented in Guatemala.

Given the number of factors to which cost-effectiveness estimates are highly sensitive--different country cost structures, differences in methodology, geographical setting, degree of targeting, program scale and program design (Levin et al., 1990)--comparisons <u>between</u> countries are problematic. What is of more interest perhaps is the relative ranking of the interventions in the different studies. Within studies, the cost-effectiveness of fortification is consistently lower than the other interventions, though capsule distribution is a close second, particularly when it is carried out in accessible areas with high population density.

Interpreting the significance of the differences in cost-effectiveness between the three interventions is not an altogether straightforward task, and there are several important qualifications to make to these findings. One concerns the nature of the effectiveness measures used: it is quite possible that the use of impact measures rather than the coverage indicators employed in Table 13 could reverse the cost-effectiveness rankings. A second relates to the comparability of the three interventions. The fortification interventions are, for example, larger than the capsule or gardening programs in each of the studies, and it is possible that economies of scale are at work disguising the relative cost-effectiveness of comparably-sized programs. Increasing production capacity usually results in output expanding more rapidly than costs because it spreads fixed costs over a larger amount of output, giving an improvement in the cost-effectiveness of a program.

Another point to consider is that different delivery strategies may be most cost-effective for specific target groups within a country, since program efficiency is greatly affected by geographical location and physical accessibility. For example, fortification may be the most cost-effective strategy for an urban population, while capsule distribution could prove more cost-effective for a remote rural population with limited consumption of the fortified product. West, et al. (1992) describe a simple, quantitative technique for setting priorities among vitamin A interventions that generates an "Efficiency Ratio" which weights prevalence of vitamin A deficiency by difficulty of access to (and indirectly, cost of reaching) the population. The results of this analysis can help decisionmakers to assess the relative efficiency of targetting interventions at different geographic areas.

Finally, Popkin et al.'s and our estimates for gardening and education indicate that this intervention is more expensive per person than either capsules or fortification. On the other hand, as we discuss further below, this intervention results in important additional health, nutrition, and income benefits such as improved caloric/protein/other micronutrient intakes and income from the sale of produce.

5.4 Choice of Effectiveness Indicator

The cost-effectiveness results are given for four different categories of beneficiaries: persons reached, high risk groups reached (women of child-bearing age and children under six years), person years of vitamin A gap eliminated by the program, and high risk person years of vitamin A gap eliminated by the program. The first two use indicators of coverage and are more relevant to discussions about financing. The second two use impact indicators and can tell us more about relative efficiency.

The study adopted a conservative approach in its definition of impact indicators. Only those individuals whose status changed from inadequate to adequate vitamin A intake were counted amongst the beneficiaries. Nevertheless, those persons whose severity of vitamin A deficiency was only attenuated and not eliminated by consuming fortified sugar, still benefitted from the program. They are not included because according to current internationally recognized conventions they remain at risk of vitamin A deficiency (IVACG, 1988). The definition of beneficiary that we have used obviously understates the effectiveness of all the programs but particularly the sugar fortification program, which reaches many with already adequate RDI and provides modest amounts of vitamin A to others who do not reach the cut-off.

Two different versions of the impact indicators are presented (one for the whole population and the other for the at-risk population). For any intervention untargetted by age and sex (e.g., fortification and gardens), the cost-effectiveness ratios will be significantly different if only high risk rather than all individuals are included as beneficiaries. The choice of indicator to a large extent depends on the objective of the program. Vitamin A programs are generally targetted at the so-called "high risk" groups of children and women of child-bearing age, since these are the groups who most frequently suffer the consequences of inadequate vitamin A intake. Thus it is clearly of interest to determine how the programs fair in terms of this target.

On the other hand, since others in the community may suffer from vitamin A deficiency and its consequences, improving their vitamin A status is clearly beneficial. An analysis which failed to take into account those benefits would be a narrow one. To some extent this debate could be resolved through a greater understanding of the distribution of the vitamin A deficiency in Guatemala. If we knew that older children, men and the elderly were little affected by vitamin A deficiency, the use of the high-risk beneficiaries indicator would seem to be appropriate.

5.5 Factors Not Taken into Account in Cost-effectiveness Analysis

Quantifiable "effectiveness" measures rarely capture all the important features or impacts of a program, and it is useful to establish additional criteria to guide the selection of the "best" program packages. The following observations illustrate the importance of these additional considerations in shaping the cost-effectiveness findings and their policy implications. Table 14 illustrates how other important criteria can be added to cost-effectiveness estimates to broaden the framework for comparing alternatives.

Non-vitamin A impacts of the programs. In contrast to the fortification program, both the capsule and gardening programs appear to offer benefits above those directly related to improving vitamin A intake:

- The supplementation intervention's coordination of capsule distribution with immunizations is reported to have tripled immunization coverage rates in some of the target communities. TBAs trained to provide capsules and nutrition education also reported an increase in demand for their services. Increases in health services demand and utilization in these low access communities could have significant implications for maternal and infant morbidity and mortality, beyond the benefits of reducing vitamin A deficiency.

- The literature on gardening activities worldwide indicates nutritional benefits beyond improving vitamin A intake (see, for instance, Soleri et al., 1991).

> These benefits that may be directly due to consumption of garden produce or, indirectly, via increased income: in the ivy gourd promotion program in Thailand, energy, fat and animal protein intakes all increased; in the comparative vitamin A intervention trial in the Philippines, protein-caloric malnutrition decreased in the primary health care/gardening group (Solon et al., 1979); in rural India income from garden production had a consistent, positive impact on protein-caloric malnutrition rates in 6-36 month old children (Kumar, 1978); garden vegetables have been shown to be the lowest cost sources of vitamins A and C, calcium and iron in typical Asian diets (Tsou, 1989). Additional benefits also include other nutrients such as vitamin C, for example, which, by improving iron absorption, can have significant benefits in reducing iron deficiency anemia.

These additional considerations can be crucial in determining the optimal allocation of resources. This is illustrated by the conclusions from a pilot program (Tilden et al., 1992) in Nepal to compare three vitamin A interventions: capsules (using community health volunteers supplied and supervised by MOH), nutrition education (using trained community health volunteers and printed pamphlets to teach mothers to use vitamin A rich foods), and primary health care (deworming, immunizations and ORT). The authors conclude that capsule distribution is the least expensive way of protecting children from low serum levels and clinical signs of vitamin A deficiency in Nepal, but nutrition education is recommended for areas with a high prevalence of stunting and wasting.

Addition benefits from vitamin A might be especially critical in areas such as the Quetzaltenango and San Marcos Project HOPE communities, where the prevalence of immunizable diseases and protein-caloric and other forms of malnutrition is high and where sustained reductions in infant and child mortality may be difficult unless these are concurrently addressed.

Program sustainability. There are at least two related issues here. The first is the feasibility of continued program support and the second is the extent to which benefits can be generated without special program inputs being required. All three programs have a high "r" value--the ratio of the recurrent costs to the capital costs of a project. This is sometimes interpreted as the level of difficulty that is likely to be encountered in sustaining a project. How true this is in the case of the three studied interventions will be influenced by other factors.

The capsule and gardens/education programs are both dependant upon USAID funding which is available for six years, 1990-1996. If this period is sufficient to cover the most critical phase of vitamin A deficiency in Guatemala, sustainability will not be an issue. Otherwise it will be important either to find other funding sources or to institutionalize these programs in some way. It seems possible that the garden/education program could achieve sustainability through effecting a permanent change in household behavior by encouraging the routine growing and consumption of vitamin A rich foods.

Sustainability may not be a major problem for the fortification option even though it does nothing to attack the root cause of vitamin A deficiency. This program is now mandated by law and the financial costs are born outside of government by, in the first instance, the sugar industry. Fortification adds very little to the cost of sugar, and the demand for sugar is relatively price inelastic, suggesting that it would be simple for the sugar industry to pass on the costs of fortification to consumers should they feel the financial need to do so (though they claim not to). This is likely to preclude development of any strong opposition to the program and suggests that fortification is a sustainable option.

Equity. An important qualitative difference in the programs is who among the target population was successfully reached. There is some evidence that supplements failed to reach 80 percent of post-partum women, thus leaving a significant proportion of young infants and women vulnerable to vitamin A deficiency. In the gardens and nutrition education program, under 10% of the target area households were reached during the first two years of the program, and these may not have been the most at-risk households in the area. Self-selection among the drop-outs is likely, given high participant costs required for maintaining gardens. In contrast, sugar fortification is all-encompassing in its ability to deliver vitamin A to all income and age groups. Those missed are a small proportion who do not consume Guatemalan processed sugar.

5.6 Conclusions

This has been an exploratory study. Its principal aim has been to use secondary data to analyze the cost-effectiveness of three vitamin A intervention programs in Guatemala.

Our main conclusion is that fortification is an economically attractive option for meeting the vitamin A needs of much of the Guatemalan population and that it also appears to be relatively sustainable and equitable. We reached this conclusion despite building in conservative assumptions concerning the benefits of fortification and comprehensive estimates of its costs. This conclusion is based on the important assumption that vitamin A levels can be maintained at reasonable levels. If the levels fall to those found in the 1989 study of vitamin A content in sugar, the attractiveness of fortification is significantly diminished. Aiming for the legally mandated level may not, however, be necessary--it appears that more modest levels (e.g., 7.3 μg/gram of sugar) would provide similar benefits. If this is the case, it has important (beneficial) cost implications, since vitamin A fortificant comprises 97% of the total costs of fortification.

There appears to be substantial wastage of fortificant. Quantities detected in sugar samples in households/stores are significantly below that which is possible given the amount of fortificant imported. Furthermore, when the level of fortification falls to that detected in 1989, roughly half of the total recurrent cost of fortification (approximately US$ 1.2 million annually) is wasted by failing to boost individuals deficient in vitamin A above RDI. The magnitude of this inefficiency suggests that it would be economically rational to continue close monitoring of the loss of vitamin A potency in fortified sugar and to boost what appear to be injudiciously small investments in monitoring (less than 3% of total costs). Significant increases in monitoring could be achieved without substantially affecting overall costs, suggesting a high payoff from increased investments in careful tracking of rural sugar supplies for vitamin A levels.

Special attention should be paid to the level of fortification in sugar distributed to rural areas. It may be possible to make greater use of sugar fortification to reach some geographical isolated groups, some of whom have persistent vitamin A deficits despite receiving (poorly) fortified sugar.

For those areas where fortified sugar is not consumed (and these need to be accurately determined) and vitamin A deficiency is highly prevalent, small-scale, carefully targeted, complementary interventions may be called for: capsules and, perhaps, gardens for sustained as well as broader impacts. Both these programs might be cost-effectively expanded in the areas they are currently serving by increasing participation rates within the program communities. At present, only a low proportion of high risk target groups participate. The bulk of costs consisting of the costs of the teams visiting the target communities and average total costs would be reduced if the sizeable fixed costs could be spread over a larger number of beneficiaries.

The findings of this study also point to areas where further research and documentation would be helpful to inform decisionmakers on future policy and program alternatives for reducing vitamin A deficiency in Guatemala. Notably, it would be important to determine what specific actions were involved in improving the level of fortification from 1989 study levels to the current estimated level of 7.3 μg. Secondly, further information is needed to identify what proportion of the Guatemalan population does not use fortified sugar and where they are located. This might be done relatively easily by adding a few questions to the next household expenditure survey to identify the brand of sugar consumed.

Our study has attempted to show that cost-effectiveness analysis can be done using existing, routinely maintained, program data--and thus eschewing undertaking the typically extraordinary efforts and incurring the substantial costs associated with special, one-time data collection efforts. However, as our study illustrates, cost-effectiveness analysis is rarely a simple exercise and some care must be taken in interpreting the results: it should not be regarded as a mechanistic means for obtaining an unequivocal, definitive determination of which program is the "best".

Furthermore, cost-effectiveness analysis is limited by its inability to capture spin-off benefits (which are substantial in the gardens intervention) or to address issues of equity and sustainability, consideration of which may alter the priorities generated from a cost-effectiveness analysis. Translating cost-effectiveness findings into responsible policy recommendations requires first assessing the significance of some of the broader policy context.

Nevertheless, cost-effectiveness analysis provides a much more concrete foundation for deciding on priorities than approaches which rely simply on a hunch, intuition or one-dimensional consideration such as coverage or impact without cost. We trust that this study will demonstrate that cost-effectiveness analysis is feasible and can provide useful information for program managers, nutrition planners and more general public policymakers.

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TABLES

TABLE 1

SUMMARY OF INTERVENTIONS

(Study Period: 1990-1992)

Vitamin A Intervention	Location	Area Population	Implementing Agency	Delivery System
1. Sugar Fortification	Nationwide	9.2 million	Sugar industry and Government of Guatemala	Retail sales
2. Capsule Distribution	2 Departments	1.2 million	Project HOPE, Min. of Health	Rural health centers, community contacts
3. Gardens/Nutrition Education	2 Departments	1.2 million	Project HOPE, Min. of Agr., other	Agricultural extension, volunteers

TABLE 2

VITAMIN A CONSUMPTION FROM SUGAR BY INCOME GROUP AND URBAN/RURAL RESIDENCE GUATEMALA (1979-1980)

RESIDENCE	HOUSEHOLD INCOME GROUP (Quetzales per annum)	SUGAR CONSUMPTION (grams/day/household)[1]	VITAMIN A CONSUMPTION FROM SUGAR (μg/day/household)		
			Scenario #1[2]	Scenario #2[3]	Scenario #3[4]
URBAN	< 1200	242	3623	1138	1763
	1200-2399	340	5103	1602	2483
	2400-7199	459	6887	2162	3352
	> 7200	600	8998	2825	4379
RURAL	< 1200	272	4087	684	1635
	1200-2399	428	6428	1076	2571
	2400-7199	589	8842	1480	3537
	> 7200	571	8565	1433	3426

[1] Source: Government of Guatemala, Household Income and Expenditures Survey, 1979-1980.

[2] Assumes 15 μg vitamin A per gram of sugar.

[3] Assumes 4.71 μg vitamin A per gram of sugar in urban areas and 2.51 μg in rural areas.

[4] Assumes 7.3 μg vitamin A per gram of sugar in urban areas and 6.0 μg in rural areas.

TABLE 3

RECOMMENDED DAILY INTAKE OF VITAMIN A (μg) PER LOW-INCOME HOUSEHOLD (INCOME < 2400 QUETZALES), BY AGE GROUP AND URBAN/RURAL RESIDENCE

Age Group (years)	Vit. A Recom.(μ g/day)	No. of Persons/ Household		Total Daily Recommended Vit. A per Household (μg)	
		Urban	Rural	Urban	Rural
Children (0-1)	350	0.1746	0.1761	61.10	61.63
Children (1-6)	400	0.8728	0.8804	349.25	352.18
Children (6-10)	400	0.8521	0.8595	340.83	343.81
Children (10-12)	500	0.3580	0.3612	179.03	180.60
Children (12-15)	600	0.3580	0.3612	214.83	216.71
Adult Women	700	1.5303	1.5436	1,071.19	1,080.50
Adult Men	600	1.5558	1.5694	933.49	941.67
Total		5.7016	5.7514	3149.59	3177.20

Source: FAO/WHO, 1988

TABLE 4

DISTRIBUTION OF HOUSEHOLDS AND POPULATION BY INCOME LEVEL AND RURAL/URBAN RESIDENCE

RESIDENCE AND INCOME GROUPS (Quetzales/Year)	HOUSEHOLDS		AVERAGE FAMILY SIZE	ESTIMATED TOTAL POPULATION	TOTAL TARGET POPULATION (44%)
	No.	%			
RURAL	1,000,357	58.6%	5.61	5,616,546	2,471,280
<1200	355,296	20.8%	5.75	2,042,952	898,899
1200-2399	444,308	26.0%	5.75	2,554,771	1,124,099
2400-7199	188,208	11.0%	5.10	959,861	422,339
>7199	12,545	0.7%	4.70	58,962	25,943
URBAN	706,299	41.4%	5.08	3,590,846	1,579,971
<1200	70,149	4.1%	5.70	399,849	175,933
1200-2399	194,632	11.4%	5.70	1,109,402	488,136
2400-7199	330,751	19.4%	4.82	1,594,220	701,457
>7199	110,767	6.5%	4.40	487,375	214,445
Total	1,706,656	100.0%		9,207,392	4,051,251

Source: Family sizes taken from United Nations Populations Estimates, 1991; proportion of households in each income category was taken from the 1979-80 national household expenditure survey.

TABLE 5. VITAMIN A CONSUMPTION IN MICROGRAMS PER HOUSEHOLD PER DAY BY INCOME LEVEL AND URBAN/RURAL RESIDENCE (AND AS A PERCENTAGE OF RDI)

CONSUMPTION OF VITAMIN A	RESIDENCE AND INCOME (Quetzales/household/year)			
	< 1200 URBAN	1200-2399 URBAN	< 1200 RURAL	1200-2399 RURAL
A) NATURAL SOURCES	1140	1140	1150	1150
B) SUGAR: Scenario #1[1]	3623	5103	4087	6428
Scenario #2[2]	1138	1602	684	1076
Scenario #3[3]	1763	2483	1635	2571
C) TOTAL = A+B: Scenario #1	4763 (151%)	6243 (198%)	5237 (165%)	7578 (238%)
Scenario #2	2278 (72%)	2742 (87%)	1834 (58%)	2226 (70%)
Scenario #3	2903 (92%)	3623 (115%)	2785 (88%)	3721 (117%)
Recommended Daily Intake (RDI)	3150	3150	3177	3177

[1] Assumes 15 μg vitamin A per gram of sugar.

[2] Assumes 4.71 μg vitamin A per gram of sugar in urban areas and 2.51 μg in rural areas.

[3] Assumes 7.3 μg vitamin A per gram of sugar IN URBAN AREAS AND 6.0 μg in rural areas.

TABLE 6

ANNUAL PROGRAM COSTS: SUGAR FORTIFICATION
(US$ 1991)

Capital Costs	Total Cost	Years of Life	Annuitizing Factor	Annual Cost	Percentage of Total Annual Cost
Measuring devices	14,400	15	7.606	1,893	...
Pre/mixer	2,000	15	7.606	263	...
Subtotal				2,156	0.1
Recurrent Costs					
Personnel					
- sugar industry				17,420	0.7
- government				12,270	0.5
Transportation				4,000	0.2
Supplies					
- Vitamin A (1)				2,300,000	96.7
- Sugar				15,000	0.6
- Ronoxan				920	...
- Vegetable oil				6,440	0.3
Utilities and rent					
- Rent and warehousing				10,800	0.5
- Utilities				200	...
Packing, laboratory analyses operations, communications and other				10,072	0.5
Subtotal				2,377,122	99.9
TOTAL				2,379,278	100.0

Notes: (1) The cost of vitamin A is figure provided by ASAZGUA for actual expenditures in 1991. Industry sources indicate that annual expenditures for vitamin A have remained fairly constant during the last several years.

TABLE 7

ANNUAL PROGRAM COSTS: CAPSULE DISTRIBUTION (1)
(US$ 1991)

Capital Costs	Total Cost	Years of Life	Annuitizing Factor	Annual Cost	Percentage of Total Annual Cost
Vehicles and equipment	3,941	10	6.145	641	0.9
Training materials	3,500	3	2.487	1,407	2.0
Subtotal				2,048	2.9
Recurrent Costs					
Personnel					
- staff (2)				28,540	39.9
- consultants				2,780	3.9
Transportation					
- maintenance, gasoline				3,600	5.0
- per diem				12,010	16.8
Supplies					
- Vitamin A				8,121	11.3
- Office supplies				508	0.7
Utilities & rent				606	0.8
Project HOPE overhead				13,343	18.6
Subtotal				69,508	97.1
TOTAL				71,556	100.0

Notes: (1) The costs are based on expenditures reported by Project HOPE for Sept. 1991-August 1992 under the vitamin A grant, plus child survival grant resources applied to vitamin A activities. The process for allocating total Project HOPE costs to gardens/nutrition education and capsule distribution is described in Annex 4.

(2) Includes staff costs for Ministry of Health and Project HOPE headquarters costs for supervision and management.

TABLE 8

EFFECTIVENESS OF THREE-YEAR INVESTMENT IN GARDENS AND NUTRITION EDUCATION UNDER TWO DIFFERENT ASSUMPTIONS OF LONG-TERM EFFECTS

YEAR	SCENARIO A[4]		SCENARIO B[5]	
	NUMBER OF FUNCTIONING GARDENS	PRESENT VALUE OF FUNCTIONING GARDENS[3]	NUMBER OF FUNCTIONING GARDENS	PRESENT VALUE OF FUNCTIONING GARDENS[3]
1991	6,753	6,753	6,753	6,753
1992	4,000 + 0.5 x "1991" = 7,376	6,639	4,000 + 0.5 x "1991" = 7,376	6,639
1993	4,000 + 0.5 x "1992" = 7,688	6,227	4,000 + 0.5 x "1992" = 7,688	6,227
1994	0.5 x "1993" = 3,844	2,802	0.5 x "1993" = 3,844	2,802
1995	0.6 x "1994" = 2,306	1,513	0.5 x "1994" = 1,992	1,261
1996	0.7 x "1995" = 1,615	953	0.5 x "1995" = 961	567
1997	0.8 x "1996" = 1,292	686	0.5 x "1996" = 481	256
1998	0.9 x "1997" = 1,163		0.5 x "1997" = 240	115
1999	1.0 x "1998" = 1,163		0.5 x "1998" = 120	52
2000	1.0 x "1998" = 1,163		0.5 x "1999" = 60	23
2001	1.0 x "1998" = 1,163	5,563[4]	0.5 x "2000" = 30	10
2002	1.0 x "1998" = 1,163		0.5 x "2001" = 15	8
2003	1.0 x "1998" = 1,163		0.5 x "2002" = 7	2
2004	1.0 x "1998" = 1,163		0.5 x "2003" = 4	1
TOTAL DISCOUNTED GARDENS		31,136		24,716
TOTAL DISCOUNTED BENEFICIARIES (FOR THREE YEARS' INVESTMENT)		(31,136 x 6.9) 214,838		(24,716 x 6.9) 170,540
TOTAL DISCOUNTED HIGH RISK BENEFICIARIES (FOR THREE YEARS' INVESTMENT)		(214,838 x .44) 94,529		(170,540 x .44) 75,038

[4] Assuming that once investment is halted, drop-outs are 50% in the first year, 40% of the previous year in the second, etc.

[5] Assuming that once investment is halted, 50% of all gardens continue to drop-out each successive year.

[3] Assuming 10% discount rate.

[4] An infinite stream of 1,163 discounted at 10% is approximately 11,630; converted to 1991 values, this is 11,630 x $(0.9)^7$ = 5,563.

TABLE 9

ANNUAL PROGRAM COSTS: GARDENS AND NUTRITION EDUCATION (1)
(US$ 1991)

Capital Costs	Total Cost	Years of Life	Annuitizing Factor	Annual Cost	Percentage of Total Annual Costs
Vehicles and equipment	14,942	10	6.145	2,432	2.9
Training materials	3,500	3	2.487	1,407	1.6
Subtotal				3,839	4.5
Recurrent Costs					
Personnel (2,3)					
- staff				37,656	44.2
Transportation					
- maintenance, gasoline				3,600	4.2
- per diem				12,010	14.1
Supplies					
- seeds				10,375	12.2
- other supplies				1,121	1.3
Utilities and rent				3,340	3.9
Project HOPE overhead				13,343	15.6
Subtotal				81,445	95.5
TOTAL				85,284	100.0

Notes:

(1) The costs are based on expenditures reported by Project HOPE for Sept. 1991-August 1992 under the vitamin A grant, plus child survival grant resources applied to vitamin A activities. The process for allocating total Project HOPE costs to gardens/nutrition education and capsule distribution is described in Annex 4.

(2) Includes Ministry of Agriculture and Ministry of Education costs.

(3) Includes Project HOPE headquarters costs for supervision and management.

TABLE 10

SUMMARY OF ESTIMATED COVERAGE AND EFFECTIVENESS FOR THE THREE VITAMIN A INTERVENTIONS

	COVERAGE		EFFECTIVENESS	
	NUMBER OF PERSONS REACHED		NUMBER OF PERSON YEARS OF VITAMIN A GAP REDUCTION	
	TOTAL	HIGH RISK	TOTAL	HIGH RISK
SUGAR FORTIFICATION Sugar fortified at:				
• low (4.71 μg urban + 2.51 μg rural)	8,280,000[1]	3,643,000[2]	1,509,251[3]	664,069[4]
• medium (7.3 μg)	8,280,000[1]	3,643,000[2]	5,496,277[5]	2,418,362[6]
• high (15 μg)	8,280,000[1]	3,643,000[2]	5,496,277[5]	2,418,362[6]
CAPSULE DISTRIBUTION One dose children:				
• excluded	46,956[7]	46,956[7]	38,405[8]	38,405[8]
• included	46,956[7]	46,956[7]	42,681[9]	42,681[9]
GARDENS				
• no long-term effects	53,372[10]	23,483[11]	46,596[12]	20,502[13]
• small long-term effects	53,372[10]	23,483[11]	56,847[14]	25,013[15]
• larger long-term effects	53,372[10]	23,483[11]	71,613[16]	31,510[17]

[1,2] 90% of population of 9.2 million consume sugar, of whom 44% are in the high risk group of children under 6 years of age and women of childbearing age.

[3,4] All urban households with annual income < 2400 are assumed to benefit. 44% of the household members are in the high risk category.

[5,6] All urban and rural households with annual income < 2400 quetzales are assume to benefit. 44% of these household members are high risk.

[7] 42,756 children and 4,200 women of childbearing age.

[8] 80% of the 42,756 children receive 2 doses and are covered for the full year (only those children are counted).

[9] In addition to the 80% of children receiving 2 doses, the 6 months protection to the 20% receiving only one dose is also included.

[10,11] 7,735 households, 6.9 members per household, 44% in high risk category.

[12,13] 10% of gardens reached do not participate, 3% would have had garden anyway, 44% in high risk category.

[14,15] Annual discounted beneficiaries for Scenario B, per Table 8 (dividing total beneficiaries by 3 years of investment).

[16,17] Annual discounted beneficiaries for Scenario A, per Table 8 (dividing total beneficiaries by 3 years of investment).

TABLE 11

SUMMARY OF COST ESTIMATES OF THE THREE VITAMIN A INTERVENTIONS

PROGRAM	ANNUAL COST (US$ 1991)
SUGAR FORTIFICATION	2,379,278
CAPSULE DISTRIBUTION	71,556
GARDENS/EDUCATION	85,284

Source: Annual costs are from Tables 6, 7 and 9 for sugar fortification, capsule distribution, and gardens/nutrition education, respectively.

TABLE 12

SUMMARY OF COST-EFFECTIVENESS ESTIMATES OF THE THREE VITAMIN A INTERVENTIONS[1]

PROGRAM	COST (US$1991) PER			
	PERSON REACHED	HIGH RISK PERSON REACHED	PERSON YEAR OF ADEQUACY ACHIEVED	HIGH RISK PERSON YEAR OF ADEQUACY ACHIEVED
FORTIFICATION				
• Low vitamin A level	0.287	0.653	1.576	3.583
• Medium vitamin A level	0.287	0.653	0.433	0.984
• High vitamin A level	0.287	0.653	0.433	0.984
CAPSULE DISTRIBUTION				
• Full year protection only	1.524	1.524	1.863	1.863
• Partial protection included	1.524	1.524	1.676	1.676
GARDENS				
• No long-term effects	1.598	3.632	1.830	4.160
• Small long-term effects	1.598	3.632	1.500	3.409
• Larger long-term effects	1.598	3.632	1.191	2.707

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1 Calculated from Tables 10 and 11.

TABLE 13

COMPARISON OF COST-EFFECTIVENESS ESTIMATES BETWEEN COUNTRIES (US$ 1991)

INTERVENTION	EFFECTIVENESS UNIT	COUNTRY STUDY				
		GUATEMALA 1979, INDONESIA 1978, AND PHILIPPINES 1975[1] US$ 1991	(US$ 1987)	PHILIPPINES 1980[1,2] US$ 1991	(US$ 1980)	GUATEMALA 1991 US$ 1991
FORTIFICATION	• per person	0.16[3]	(0.14)	0.14	(0.096)	0.29
	• per high risk person	0.37	(0.32)	0.32	(0.22)	0.65
CAPSULE DISTRIBUTION	• per high risk person	0.48[4]	(0.42)	0.32	(0.22)	1.52
GARDENING	• per person			2.32	(1.58)	1.60
	• per high risk person					3.63

1 Converted to 1991 values using US$ inflation rates for the periods: 4.3% per annum (1980-87) (WDR, 1989), 4.2% 1980-1991 (WDR, 1993), and 4.0% 1987-91.

2 Popkin et al., 1980 based on pilot programs to compare capsules, fortification of MSG, and primary health care combined with gardening in different urban and rural areas. Private costs (65% of total) were only included in estimates for the gardening intervention.

3 Levin et al. (1990) based on data from sugar fortification pilot trials in Guatemala in 1979 in which vitamin A levels of 15 μg were maintained (Arroyave et al., 1981).

4 Levin et al. (1990) based on Indonesia and Philippines data from 1978 and 1975, respectively, on the cost per child under 6 years receiving two capsules (West and Sommer, 1984).

TABLE 14

EXAMPLE OF THE USE OF COST-EFFECTIVENESS ESTIMATES WITHIN A BROADER FRAMEWORK FOR COMPARING THE THREE VITAMIN A INTERVENTIONS

	COST-EFFECT. ($ PER)	PROVEN IMPACT	SCALE	SUSTAINABILITY		OTHER BENEFITS
PROGRAM	High Risk Beneficiary	Mortality/ Morbidity	Adequate for Nat'l Targets	Proven Delivery System	Permanent Benefits	Broader Nut./Health Effects
SUGAR FORTIFICATION -Medium/high level	0.98	+ + +	+ + +	+ + +	-	-
CAPSULES -Full year -Partial protection	1.86 1.68	+ + +	?	?	-	+ +
GARDENS/EDUCATION -Small LT effects -Larger LT effects	3.41 2.71	?	?	?	+ + +	+ + +

ANNEXES: ANNUAL RECURRENT COSTS

ANNEX 1
SUGAR FORTIFICATION ANNUAL RECURRENT COSTS
(1991)

	Sugar Industry (ASAZGUA)	Government	Other	TOTAL
Personnel				
Director		$3,000		$3,000
Technical	$4,500	$4,770		$9,270
Inspectors (4)		$3,600		$3,600
Administrative	$4,320			$4,320
Support	$600	$900		$1,500
Workers	$8,000			$8,000
Subtotal Personnel	$17,420	$12,270		$29,690
Operations and Maintenance				
Rent	$10,800			$10,800
Operations	$10,000			$10,000
Pre-Mix Analyses			$200	$200
Sugar	$15,000			$15,000
Transportation	$4,000			$4,000
Warehousing		$1,200		$1,200
Laboratory		$270		$270
Ronoxan	$920			$920
Vegetable Oil	$6,440			$6,440
Packing	$3,250			$3,250
Utilities	$200			$200
Communications	$72			$72
Subtotal Operations and Maintenance	$50,682	$1,470	$200	$52,352
Vitamin A	$2,300,000			$2,300,000
TOTAL	$2,368,102	$13,740	$200	$2,382,042

Notes: (1) Equipment and personnel costs will vary in each country according to the number of sugar refineries. Each of the 17 refineries in Guatemala has a measuring device installed. ASAZGUA has three workers assigned to each refinery to monitor fortification (one for each shift of 24-hour/day operations).

(2) R & D costs for developing the sugar fortification technology have not been included. These were incurred 15 year ago, and the benefits are being shared by other countries as well.

(3) Data collected by McKigney and Vargas (6/92) from ASAZGUA, MOH and INCAP.

(4) Exchange rates were used to estimate 1991 costs of a 4-year program as follows:

1991	5.0289	100	1.00
1990	4.4858	89	1.12
1989	2.8161	56	1.79
1988	2.6196	52	1.92

ANNEX 2
SUPPLEMENTS ANNUAL RECURRENT COSTS
(9/1/91 - 8/31/92)

	HOPE/USAID	Donor	MOH	TOTAL
PERSONNEL				
Personnel headquarters				
Technical	2,503	0	0	2,503
Administrative	831	0	0	831
Support	1,758	0	0	1,758
Subtotal	5,091	0	0	5,091
Personnel field				
Technical	13,335	0	2,142	15,477
Administrative	3,638	0	0	3,638
Support	4,334	0	0	4,334
Subtotal	21,307	0	2,142	23,449
TOTAL PERSONNEL	26,398	0	2,142	28,540
OPERATIONS AND MAINTENANCE				
Operations/Maintenance HQ				
Overhead	2,614	0	0	2,614
Per Diem	7,498	0	0	7,498
Subtotal	10,112	0	0	10,112
Operations and Maintenance Field				
Overhead	10,729	0	0	10,729
Per Diem	4,512	0	0	4,512
Supplies	508	0	0	508
Utilities and Communications	606	0	0	606
Vehicle and Maintenance	3,600	0	0	3,600
Consultants	2,780	0	0	2,780
Subtotal	22,735	0	0	22,735
Total Operations	32,847	0	0	32,847
VITAMIN A	0	8,121	0	8,121
TOTAL RECURRENT COSTS	59,245	8,121	2,142	69,508

Notes: (1) Data from Project HOPE Annual Report Form A: Country Project Pipeline Analysis (1992). Additional resources were costed out by Project Hope managers in collaboration with McKigney, Vargas and Sanghvi.

(2) Capsule costs are estimated at US$ 0.02 per capsule for 406,050 capsules provided to health facilities and health staff.

ANNEX 3
GARDENS AND NUTRITION EDUCATION ANNUAL RECURRENT COSTS
(9/1/91 - 8/31/92)

	HOPE/ USAID	Donor	DIGESA	MOE	MOH	CR	TOTAL
RECURRENT COSTS							
PERSONNEL							
Personnel headquarters							
Technical	2,503	0			0		2,503
Administrative	831	0			0		831
Support	1,758	0			0		1,758
Subtotal	5,091	0			0		5,091
Personnel field							
Technical	13,335	0	1,674	2,254	4,000		21,263
Administrative	6,756	0			0	212	6,968
Support	4,334	0			0		4,334
Subtotal	24,425	0	1,674	2,254	4,000	212	32,565
TOTAL PERSONNEL	29,516	0	1,674	2,254	4,000	212	37,656
OPERATIONS & MAINTENANCE							
Operations/Maintenance HQ							
Overhead	2,614	0			0		2,614
Per Diem	7,498	0			0		7,498
Subtotal	10,112	0			0		10,112
Operations and Maintenance Field							
Overhead	10,729	0			0		10,729
Per Diem	4,512	0			0		4,512
Supplies	288	0		833	0		1,121
Utilities and Communications	2,858	0	482		0		3,340
Vehicle and Maintenance	3,600	0			0		3,600
Subtotal	21,987	0	482	833	0	0	23,302
Total Operations	32,099	0	482	833	0	0	33,414
SEEDS		10,375					10,375
TOTAL RECURRENT COSTS	61,615	10,375	2,156	3,087	4,000	212	81,445

Notes: (1) Data from Project HOPE Annual Report Form A: Country Project Pipeline Analysis (1992). Additional resources were costed out by Project HOPE managers in collaboration with McKigney, Vargas and Sanghvi.

(2) The cost of seeds is the market price of seeds as estimated by the Burpee Seed Co.

(3) CR is Comision Regional - a multisectoral coordinating group.

ANNEX 4

NOTES ON ALLOCATION OF PROJECT HOPE COSTS TO CAPSULE DISTRIBUTION AND GARDENS/NUTRITION EDUCATION

BACKGROUND

Project HOPE, a U.S.-based PVO headquartered in Millwood, Virginia has been active in providing basic health services in the Quetzaltenango and San Marcos Departments of Guatemala for several years. In response to USAID's announcement that funding was available to PVOs interested in adding vitamin A interventions to their child survival activities, Project HOPE designed a program that included capsule distribution, gardening and nutrition education and was awarded a three year grant covering the period 9/90 through 9/93.

METHODOLOGY

The starting point was to identify all activities that were undertaken to initiate and maintain the program and the resources that were used in each activity. In addition to resources used from USAID grants and Project HOPE's own private resources, the nature and level of other resources used in the program from government, INCAP and other private donors were itemized. Using unit costs for each resource identified, the total costs by each source was calculated per program year. The next step consisted of allocating line items and proportions of shared staff and other resources to capsule distribution activities and to gardening/education activities for each program year.

Data on costs were obtained by year in which they were incurred (or year in which goods were donated to the program), by source of support, by categories of costs (initial investment and recurrent), and by line item.

PROGRAM ACTIVITIES

Initial program start-up activities in Guatemala during 9/90 to 1/91 included hiring personnel, procurement of motorcycles and office supplies/equipment, training and orientation of staff for the baseline survey, and coordination with government and other counterparts. Full-time staff funded by USAID/Project HOPE based in Quetzaltenango include a project director, two physicians, two agronomists (under category of technical personnel in the cost table), an office manager (under the cost category of administrative personnel), a data management specialist, a secretary, and a driver/warehouseman (support personnel). Staff at Project HOPE headquarters who backstop the vitamin A program part time include the Child Survival director (technical), a secretary (support), and an accountant (administrative).

The baseline survey was undertaken in early 1991. Training and community activities for capsule distribution and gardening/education began around mid-1991. Donated seeds were received at this time, and the first of two donations of capsules were received in the third quarter of 1991. Gardening and education activities were thus starting up during the first growing season of 6/91-12/91. The first round of capsule distribution occurred in late 1991 and included the entire population of 53 communities of Quetzaltenango and San Marcos.

After the analyses of the baseline survey data, the 24 communities with the highest prevalence of low serum vitamin A were selected for future program activities. Coverage and effectiveness estimates are from these 24 communities. By the end of the first project implementation year in 9/91, it became clear that the demands of vitamin A activities exceeded the planned budget of the vitamin A grant program. Project HOPE began using additional resources available from other programs. The additional staff included one physician and two agricultural extension workers.

DATA SOURCES

Project HOPE and USAID

Data on Project HOPE and USAID funding for the period 9/01/90 through 8/31/91 were obtained from records on expenditures by categories and sources of financing maintained by Project HOPE that were reported to USAID as part of the vitamin A grant requirements in the 1991 Annual Report Form A: Country Project Pipeline Analysis (Annual Report: Year One Appendix I, Project HOPE, November 1991). For the period 9/91-6/92, annual expenditures from the Vitamin A Grant pipeline analysis in Annual Report for Year Two were prorated for 9 months and added to resources used from other USAID-funded programs operating in the area. These additional costs were estimated by listing the staff and other items used (based on discussions of McKigney and Vargas with field staff in 6/92 and Sanghvi/Orellana conversation in 1/93), the level at which they were used for vitamin A activities, and the unit costs/salaries for each item. They are as follows:

Capsule Distribution:

- training materials $ 3,500
- 1 full-time physician @ US$ 3,725/year
- per diems for staff @ US $ 7,000/year
- vehicle maintenance @ US $ 3,600/year

Gardens/Education:

- 2 full-time agricultural extension workers	@ US$ 3,360/year
- per diems for staff	@ US$ 7,000/year
- training materials	@ US$ 3,500
- vehicle maintenance	@ US$ 3,600/year

Government

Estimates of resources used and unit costs were obtained from Ministry of Agriculture (DIGESA), MOH and Project HOPE field staff in 6/92. For estimating the costs of gardening/education activities, the salaries of one extensionist, one home educator, and five agriculture representatives from the Ministry of Agriculture (DIGESA) are included for a six month period (June-December), and the cost of one agricultural guide. The Ministry of Health input includes the per diem of 20 rural health technicians (100 days per year) for promotion of gardens and nutrition education. The salary and per diems of 8 vitamin A regional commission members to attend meetings 4 times per year are included. The costs of MOH participation in capsule distribution include 7 days per diem/travel costs for each of 24 auxiliary nurses and 15 rural health technicians per year and 3 days costs of 20 nurses, plus another 4 days each of rural health technicians and auxiliary nurses for vitamin A delivery to health centers and posts. DIGESA and MOH infrastructure (buildings, administration) costs are not included. Ten days of salary for 7 school teachers have been included to cover the costs of the teachers' involvement in school gardens and nutrition education given to school children.

Donated Goods

The Burpee Seed company provided the market value of the donated seeds ($41,500). One-fourth of the quantity is estimated by Project HOPE staff to be adequate for each year of project implementation, and should be procured fresh annually. The total estimated value divided by four is the annual attributed cost of seeds. The procurement price of capsules from Hoffman La Roche has been 2 cents per capsule (200,000 IU each) for the duration of the project, and the total number of capsules distributed in each year (299,704 in 1991 and 106,342 in 1992) were numbers provided by Project HOPE field staff to McKigney and Vargas in 6/92). The number of capsules available may have been actually larger but were not distributed during the program period included in the study.

ALLOCATION OF USAID & PROJECT HOPE COSTS BY ACTIVITY

The following proportions and amounts of total costs were allocated to capsule distribution and gardening/education activities (based on discussions of McKigney and Vargas with field staff in 6/92). For 1991 (9/01/90-8/31/91), the proportions were applied to expenditures as shown in the first Annual Report Form A Appendix I. For 1992 (9/01/91-6/30/92), the same proportions were applied to expenditures shown in the pipeline analysis in Form A of Project HOPE's Annual Report for Year Two.

	Total (US$)	Capsule Distr.	Gardens/Ed.
Start-up Costs:			
Baseline Survey	31,992	0.50	0.50
Training Materials	7,000	0.50	0.50
Capital Costs:			
Motorcycles & Equipment	18,883	0.20	0.80
Recurrent Costs:			
Personnel:			
- HQ			
Technical	5,006	0.50	0.50
Administrative	1,662	0.50	0.50
Support	3,516	0.50	0.50
- Consultants	2,780	1.00	0.00
- Field			
Technical	26,670	0.50	0.50
Administrative	10,394	0.35	0.65
Support	8,668	0.50	0.50
Operations & Maintenance:			
- HQ			
Overhead	5,228	0.50	0.50
Per Diem	14,996	0.50	0.50
- Field			
Overhead	21,458	0.50	0.50
Per diem	9,024	0.50	0.50
Supplies(1)	24,000	0.21	0.12
Utilities, Rent & Communications (1)	4,175	0.14	0.68
Vehicle & Maintenance	7,200	0.50	0.50
Capsules	8,121	1.00	0.00
Seeds	10,375	0.00	1.00

Notes: (1) The base expenditure for these line items refer to all Project HOPE programs based in Quetzaltenango, not vitamin A grant activities alone.